REVIEW OF THE NOS
CENTER FOR COASTAL ENVIRONMENTAL HEALTH
AND BIOMOLECULAR RESEARCH

CHARLESTON, SOUTH CAROLINA

Review Panel

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EXECUTIVE SUMMARY

NOS posed three key questions with regard to the review of the NOS Center for Coastal Environmental Health and Biomolecular Research at Charleston (CCEHBR):

- What is the quality of the science being done?
- How well is CCEHBR connected to its clients?
- How well does CCEHBR function as an integrated research laboratory, rather than as a series of separate research units?

The Panel drew positive conclusions regarding all three questions. The science is relevant and good, much of it excellent. CCEHBR serves a diverse community of local, regional, national, and even international clients, who seem uniformly satisfied with the products they receive. CCEHBR has six separate business and organization lines, and although there are always opportunities for greater synergy, related research teams generally complement each other's work well and there is strong integration with the larger research community in the Charleston area.

The Mission Statement and five supporting Goals of CCEHBR are appropriate for a NOAA laboratory. Together they address several of the overarching themes that the NOAA Science Advisory Board has identified as important parameters to consider relative to reviews of NOAA science projects and programs. All parts of the Center are conducting molecular, cellular and/or biochemical research, development, and application of methods to address problems of system health and response to anthropogenic perturbations all the way up to the community and ecosystem scale. The work of CCEHBR spans the full continuum from basic research for discovery of new knowledge to application of existing techniques to diagnose and remedy immediate problems in coastal environmental health. This characteristic of working at the molecular, cellular and/or biochemical scales gives the Center an **overall research identity** that is unique within NOAA. Were any current major science services or research programs terminated or greatly curtailed here, to the Panel's knowledge no other NOAA lab could fill the gap that would result, without large investment in new people and facilities.

To the Review Panel, the single most serious challenge facing every component of CCEHBR is **Recruitment and Retention** of talented young science staff. Although good young scientists are attracted to work at CCEHBR, due to budget problems almost all the younger staff are in contractual or limited term positions. This inability to offer permanent employment is costly in terms of lost investment in training new staff, and also aggravates the **diversity** inequity in the current staff of the Center. The Review Panel is satisfied that a solution to the problems faced by CCEHBR in funding the staffing of FTEs cannot be found by reshuffling its annual operating budget. The funding level for and funding formula among the research centers with NOS has to be augmented

significantly, if CCEHBR is to able to resolve its recruitment and retention crisis.

Ranking close to the problem with recruitment and retention of personnel is concern over **infrastructure and insufficient laboratory facilities.** To an unknown extent opening of the Hollings Building may alleviate some of the problems of simple crowding, although the Panel had concerns over the complex protocols for obtaining access to space in the Hollis Building. There is also a looming **crisis in major equipment**. Some important specialized pieces of research equipment are obsolete, others overused, and some both, and a very large infusion of money for new and upgraded research instrumentation is needed.

CCEHBR has been very successful in forging partnerships and finding external money. However, increasing dependence on external funding is compromising the service role of CCEHBR as a group of experts able to react quickly to coastal environmental crises as they occur. The Review Panel encourages development of an **explicit policy on priority of staff time.** The purpose of the policy would be to ensure that in times when expertise in CCEHBR is needed to address NOAA priorities and emergencies, there are no conflicts or misunderstandings. It has been proposed that CCEHBR should provide its "science on demand" service on a **pay-for-service** basis. The Review Panel encourages efforts to make sure that cost recovery gets due consideration whenever CCEHBR expertise and services are made available outside NOAA. However, it supports continuation of the practice of making CCEHBR expertise available on the basis of scientific need and the match between needs and CCEHBR services, and not discriminating on the basis of ability to pay. The Review Panel also noted the need for a **clear mechanism for deciding when and how the science knowledge and services are provided to outside interests.**

With regard to **institutional setting**, both the Review Panel and the CCEHBR administration felt that the service component of CCEHBR science was crucial, and an argument for keeping CCEHBR in NOS rather than moving it to OAR. However, for the Panel to endorse the present organizational location of CCEHBR NOS must make a stronger commitment in actions and funding to support science for discovering new knowledge as well as applying knowledge to the problems of coastal ecosystems and coastal communities.

The Review Panel concluded that CCEHBR staff has produced many worthwhile scientific publications, but productivity was skewed strongly, with relatively few researchers producing the bulk of the major papers. The Review Panel also noted a number of effective community, regional, and national committees, working groups, and other for a dedicated to application of science results to environmental problems. In these areas CCEHBR staff perform important services and have clearly earned widespread respect from colleagues, community leaders, and citizens.

A noteworthy shortcoming of the total research community at CCEHBR is the weak

representation of **social sciences**. The Review Panel recommends that priority be given to forging greater collaborative links to social scientists in academic and government centers in the region. Researchers also repeatedly stressed the need for stronger commitment to **longer-term research**. While justifiably proud of their ability to adjust to changing NOAA and NOS priorities, and respond quickly to new crises, an important part of achieving the NOAA and NOS mandate requires continuity of research and monitoring.

The Marine Ecotoxicology Branch comprises four research programs in contaminant chemistry, environmental microbiology, toxicology and environmental modeling and assessment. The first three programs conduct fundamental investigations into their respective areas, while the fourth integrates the knowledge gained from these studies and also from the larger research arena conducted outside of NOAA. The Panel concurs with the Branch self-assessment that Branch studies and research products have found high usage among the many agencies in the southeast that are responsible for protection of the coastal zone. MEB strong points include:

- High quality of science, very strong interdisciplinary research ranging from the molecular to ecosystem level.
- Ability to integrate across programs and among branches.
- Outstanding record of collaborations partners and success in obtaining extramural funding
- Strong partnerships with universities through faculty appointments, educational outreach programs and mentoring of students.
- Outstanding leadership in coastal pollution and land use issues and ability to turn basic and applied research into plans of action.

The Panel concluded that weaker points of MEB included:

- Lack of federal FTE positions for junior level staff; many are on contractual arrangements.
- Lack of advancement to Senior Level Scientist (GS15) and lack of predictable career advancement.
- Lack of training for junior staff that enter supervisory positions.
- Reliance on extramural funding, requiring substantial time spent "chasing money" rather than conducting research.
- The "rust-out phenomenon". Some of the analytical and field equipment is old and needs to be replaced in the near future.
- Number of scientific publications, from staff other than the two or three "high-liners" in the Branch, and the need for targeting more prestigious journals.
- The MEB research program lacks an atmospheric component, and should strengthen the chemical modeling component of its work.
- The branch could do a better job of selling itself, nationally and internationally. MEB successes should be made more available.

The Pathobiology Branch (Oxford, Maryland**)** emphasizes fundamental expertise in invertebrate pathobiology while improving their ability to rapidly respond to emerging coastal health issues impacting valuable resources. Pathobiology Branch staff are uniquely skilled to apply a multi-disciplinary approach to understanding the causes and effects of disease on marine invertebrate populations with their knowledge of biology, ecology, oceanography, and marine biology. The Panel finds that Pathobiology Branch science is of exceptional quality and is unique within NOAA. However, it appears that the expertise and national importance of the Branch has neither been recognized nor adequately supported over the last five years. Funding and vital scientific staff positions have been lost and there is a lack of long-term line office or agency-wide research projects or lack of agency support for this group. The review also identified unfilled critical research staff positions, vacated through retirement and inadequate funding to hire replacements. Funding losses have prevented the updating of old equipment which has had negatively impacted Branch research.

The Coastal Research Branch, through the Marine Biotoxins Program and other related units, provides scientific guidance and directed research to promote effective management of living marine resources, ecosystem health and public health on issues involving marine toxins and harmful algae. The group is able to assess fate and effect of biotoxins or phycotoxins in the food web and environment, and to research and identify new toxins and new resource threats. The main strengths of the branch are its staff and their approach to sound science in support of sound, science-based decision-making. In addition, the Branch provides excellent training to students and provides technology transfer to scientists and managers at the national and international level. CRB staff are able to provide emergency response for a HAB event and are sought for not only initial screening to identify the problem but for final identification of the biotoxins involved. Weaknesses in the program result from trying to serve several masters and from inadequate resources. Although CRB is highly responsive to user needs, there has not been a survey of needs as identified by the user or customer. Such a review might help to provide clearer choices among competing priorities, as well as focus discussion better on whether the CRB should be strictly service or whether it should be technology development, verification, technology transfer and development of long term databases.

The Living Resources Branch programs are focused on the assessment of health of marine organisms and determination of the effects of environmental stressors and impacts on those organisms and their ecosystems. The research targets these processes at the physiological and molecular levels, as well as incorporating biotechnological techniques to elucidate ecosystem processes and effects. There are three primary research areas: (1) functional genomics and molecular genetics, including biodiversity, species identification, characterization of gene expression to elucidate biochemical and genetic control mechanisms; (2) biomarkers for assessing ecosystem health and determining disease processes, which involves the search for new markers to indicate the presence of stressors or various types; and (3) marine mammal health assessment, which is focused

primarily on the responses of the bottlenose dolphin to various stressors. The panel was very impressed with the quality of the research, and in particular with the attempts to incorporate modern molecular tools and approaches into the various aspects of the program. There are enormous opportunities in the Branch, particularly in areas relating to biotechnological research. The greatest obstacle to scientific progress appears to be researcher and technical staff needs.

The Risk Analysis and Information Management Branch incorporates two important functions: the management of information and the use of that information for risk analysis. The risk analysis effort is focused on four areas: (1) shellfish pathogens risk reduction (focused on vibrios); (2) national shellfish information system (SIMS); (3) ecological characterization (presently focused on Cape Romain National Wildlife Refuge):, and (4) spatial data analysis service and support (e.g. GIS). This Branch covers essential needs of CCEHBR in the areas of computer and database support, information management, and the use of information to develop approaches for risk analysis. It is necessary that the infrastructure and expertise of the Branch keeps pace with the rapid development of information technologies and increase in environmental information.

The Forensic Branch is an applied multidisciplinary branch that is staffed with assigned personnel as well as other CCEHBR staff when needed for specific cases. The Branch provides analytical examination of evidentiary material submitted by State and Federal Law Enforcement agencies in cases involving endangered, protected, or regulated marine species. The major significance of the Forensic Branch is that it enables State and Federal Law Enforcement officers to prosecute violators of wildlife laws and thus protect dwindling marine resources. There is no other Laboratory in the USA that can assist Federal Law Enforcement officers with marine violations. The main strengths of the Branch include:

- Sole source analytical support for Federal Law Enforcement officers enforcing marine violations.
- An understanding of the Legal system.
- Court accepted science
- Very strong interdisciplinary research.

The Branch weaker points include:

- Despite some achievements, the Forensic Branch should increase the number of peer-reviewed publications.
- The Forensic Branch research program lacks a Proteomics component.
- Lack of an on-staff Veterinary Pathologist.
- Lack of scientists (FTE or contractual).

OVERVIEW

NOS posed three key questions with regard to the review of the NOS Center for Coastal Environmental Health and Biomolecular Research at Charleston (hereafter CCEHBR):

- What is the quality of the science being done?
- How well is CCEHBR connected to its clients?
- How well does CCEHBR function as an integrated research laboratory, rather than as a series of separate research units?

The first point to be made is that CCEHBR accounts well for itself on all three questions. The science is relevant and good, much of it excellent. CCEHBR serves a diverse community of local, regional, national, and even international clients, who seem uniformly satisfied with the products they receive. CCEHBR has six separate business and organization lines, and although there are always opportunities for greater synergy, related research teams generally complement each other's work well, and there is strong integration with the larger research community in the Charleston area. Notwithstanding the positive response to all three of the basic NOS questions, all research institutions have room – and desire – to improve. The Review Panel report appropriately will give much attention to opportunities for improvement at CCEHBR, but this selective attention should not distort the key message above.

Strong performance of a government-based science center is more than individuals conducting good research. A review of CCEHBR should include an assessment of the overall mission and goals set for the Center, and performance relative to them, as well as the performance of researchers relative to the standards of their disciplines. In the case of CCEHBR, the Mission statement is clear and appropriate for a government research center addressing coastal environmental health and biomolecular research:

> **Mission Statement:** Conduct research to characterize the health of the coastal environment and provide science-based strategies to sustain and restore coastal ecosystems.

The Mission Statement is supported by five **Goals**:

1. Conduct research to develop and apply tools related to coastal ecosystem health and living marine resource problems.
2. Use research findings to assess impacts of multiple natural and anthropogenic stressors on coastal ecosystem health.
3. Develop predictive capabilities to enhance forecasting of coastal habitat and living marine resource alterations affecting coastal ecosystem health and develop risk-reduction / environmental management strategies to sustain healthy coasts.
4. Use strong partnerships for research planning, conduct and communication.

5. Communicate information by a wide variety of outlets.

These five goals are appropriate. They support the Mission Statement, and represent several of the overarching themes that the NOAA Science Advisory Board has identified as important parameters to consider relative to reviews of NOAA science projects and programs. The Review Panel notes that the goals emphasize the creation of new knowledge (particularly Goals 1, and 3), the application of knowledge to specific problems (particularly Goals 2 and 3), and the building of capacities both within CCEHBR and among clients (particularly Goals 4 and 5). The NOAA SAB themes of Quality, Creativity, and Credibility, may be addressed most directly by Goal 1, whereas Timeliness, Scale and Scope are addressed primarily by Goals 2 and 3. Science Connectedness to Policy is addressed in various ways by Goals 1, 2, and 3. Capacity Building and Education are both addressed directly by Goals 4 and 5, and Efficiency is addressed primarily through Goal 4. Hence, evaluating the degree to which CCEHBR is achieving its 5 goals is evaluating the extent to which six of the eight NOAA SAB themes are taken into account in the work of CCEHRB. (The final two, on Social Science Integration and Diversity will be addressed separately)

The material prepared by CCEBHR for the Review Panel was organized and presented separately for each of the six Branches of CCEHBR:

- Marine Forensics
- Risk Analysis and Information Management Research
- Pathology Research
- Coastal Research
- Living Marine Resources Research
- Marine Ecotoxicology

Correspondingly, the Panel's comments are also organized by the six research Branches. However, a number of crosscutting observations can be made. These should be considered along with the more detailed comments provided on the individual program lines.

GENERAL THEMES

When considering the corpus of material presented to the Review Panel by the six Branches at CCEBHR, the Panel saw a common thread that united all the work at CCEBHR. **All Branches of the Center are conducting molecular, cellular and/or biochemical research, development, and application of methods in support of NOAA's mission**. Working at this sub-organism level, researchers may address problems of system health and response to anthropogenic perturbations all the way up to the community and ecosystem scale. With this sub-organism emphasis and within NOAA's mandate, the work of CCEHBR spans the full continuum from basic research

for discovery of new knowledge to application of existing techniques for diagnosis and remediation of immediate problems in coastal environmental health.

This characteristic of working at the molecular, cellular and/or biochemical scales gives the Center an **overall research identity** that is unique within NOAA. The common identity is a strength in itself, because individuals can see that their work really belongs within the research community at CCEHBR. The common identity to CCEHBR has an additional important implication. Were any current major science services or research programs terminated or greatly curtailed here, to the Panel's knowledge no other NOAA lab could fill the gap that would result, without large investment in new people and facilities.

Although the molecular, cellular and/or biochemical research is often applied at the community and ecosystem scales, a large part of the research on population and community dynamics itself is done elsewhere. There is some community and ecosystem level research of high quality within parts of CCEBHR, particularly in the Coastal Research and the Risk Analysis and Information Management sections. However most of the work on such scales is done by or with external partners, including other parts of NOAA. The Review Panel strongly supports continuation of these linkage and collaborative arrangements, rather than building larger programs in marine population and community ecology, where NOAA already has several strong Centers. The Review Panel encourages that linkages with theoretical community and systems ecologists also be strengthened, to complement the strong linkages to field community ecologists. Supportive linkages with both theoretical and field community ecologists give greater credibility to the excellent work being done in areas like indicators of ecosystem health.

To the Review Panel, the single most serious challenge facing every component of CCEHBR is **Recruitment and Retention** of talented young science staff. CCEHBR has an excellent record of attracting talented young scientists, both as graduate students and into entry-level science positions. Unfortunately, due to budget limitations almost all the younger staff are on contractual or limited term positions. They all know or learn quickly that in the current funding situation there is little prospect of moving from the contractual or term positions to permanent ones, so they are on career tracks with little or no medium-term security. Although the Review Panel members were favorably impressed with the enthusiasm and clarity with which all the younger scientists discussed their work, the lack of prospects for permanent employment did affect their morale negatively. Many impressive younger staff said they would prefer to stay at CCEHBR but were continually watching for other, more permanent, posts, because they required greater career stability in order to allow personal and family objectives to be pursued. The uncertain staffing situation also reduces the productivity and efficiency of the Center, because as contract or term staff receives more training and acquire more skills on the job at CCEHBR, their ability to attract offers of permanent positions from other employers increases. Their departure costs CCEHBR the investment in training (even though it increases capacity elsewhere), and some projects depends so heavily on key contractual

staff that loss of these individuals would make timely and successful completion of the projects unlikely.

This inability to offer permanent employment also aggravates the **diversity** inequity in the current staff of the Center. CCEHBR has addressed gender equity effectively in both research teams and administration, but minorities are under-represented on staff and in management. Senior CCEHBR administrators are clearly aware of this imbalance, and the Review Panel concluded that they are sincere in efforts to address it. They have a good record of attracting minorities to graduate science positions, and providing good mentoring. However, competition for skilled scientists from minorities is intense, and with only contractual or term positions to offer, most of graduate students from under-represented groups accept jobs elsewhere that offer greater security and potential for advancement.

The inability to staff permanent positions with young scientists characterizes all of CCEHBR, although the situation is most serious at the Oxford Laboratory. The Review Panel was informed that at the Oxford Laboratory, site of pathobiology research programs that are internationally prestigious and unique within the US, there is not a scientist under forty years of age. As the Review Panel understands the situation, the problem is not a lack of allocated FTE's to staff, but a lack of salary dollars for supporting these vacant FTE's. The salary short-fall, in turn, is a consequence of some complex funding algorithms within NOS, to deal with multi-million dollar short-falls in funds transferred to the science unit within NOS at the time that several laboratories and their accompanying mandates were transferred into the NOS National Centers for Coastal Ocean Science. The Review Panel considered the intricacies of these funding formulae to be outside its mandate. However, it is satisfied that a solution to the problems faced by CCEHBR in funding the staffing of FTEs cannot be found by reshuffling its annual operating budget. The funding level for and funding formula among the research centers with NOS has to be augmented significantly, if CCEHBR is to able to resolve its recruitment and retention crisis. If this problem cannot be addressed promptly and effectively, the viability of CCEHBR as a dynamic center for discovery, innovation and application of science to near-coastal environmental quality concerns will be in jeopardy.

Ranking close to the problem with recruitment and retention of personnel is concern over **infrastructure and insufficient laboratory facilities.** To an unknown extent opening of the Hollings Marine Laboratory may alleviate some of the problems of simple crowding, although several Review Panel members felt the complex rules and procedures for access to space and facilities and complex system for administration and management of the facility had a high risk of creating a nightmare of bureaucracy. However, no one can be sure how it will work until the building is in operation, and the fact that several groups from academia and government are to share the facility give some reason for the administrative complexities. The Review Panel does feel that the administration of the facility should be reviewed after a few years of operation to ensure that the best science is being done with reasonable efficiency.

Regardless of the contribution that the Hollings Marine Laboratory may make to reducing overcrowding, there is a looming **crisis in major equipment**. Some important specialized pieces of research equipment are obsolete, others overused, and some both. Specific needs are discussed in the reviews of the individual programs, but as a major concern, a very large infusion of money for new and upgraded research instrumentation is needed. If it is the case that much of the initial allocation of money for equipment for the Hollings Marine Laboratory was reallocated (whether to complete the physical plant itself or elsewhere), then this need is even greater. It is a reality that a science center with a focus on molecular, cellular and biochemical research and development needs state-of-the-art equipment to achieve its potential and to keep the best scientists. Equipment a decade old, running nearly around the clock, seven days a week, is simply not adequate for the Center to stay viable in the medium term. There is no question that NOAA needs the unique expertise in CCEHBR, and should attach very high priority to finding funds for renewing equipment as well as augmenting staff.

The severe constraints on staffing positions in CCEHBR, and overall restrictive funding environment have given increased incentive for CEHBR to make external partnerships and obtain **external funding**. CCEHBR has been very successful in forging partnerships and finding external money, which is a testimony to the quality of the science and service provided by CCEHBR. However, increasing dependence on external funding is a path with many dangers, in addition to the opportunities it presents. The role of CCEHBR as a "science on demand" facility; that is, a group of experts able to react quickly to coastal environmental crises as they occur, can be compromised if a significant portion of the scientific expertise is committed to completing contractual obligations with external sources of funding. Commonly the best researchers can attract the most external funding, so exactly the expertise most valuable to the Center's administration and to NOAA may become least accountable and available to them. External funding gives the holder greater independence from management direction, and creates a set of accountabilities and deadlines that may not have the flexibility needed to accommodate quickly arising needs of NOAA.

The Review Panel does not discourage the seeking of external funding by CCEHBR; indeed, some programs would not be viable without it. However, it does encourage development of an **explicit policy on priority of staff time.** The purpose of the policy would be to ensure that in times when expertise in CCEHBR is needed to address NOAA priorities and emergencies, there are no conflicts or misunderstandings. The policy should clarify that staff whose salaries are paid by NOAA are accountable to the Director of CCEHBR ahead of all other professional commitments. Priority for access to limited equipment can also be set by the Center Director and management team. Such an explicit policy would not just protect the interests of NOAA and the authority of the Center's Director, but would protect the individual scientist when entering into agreements for external funding. The Review Panel was assured that to this point, there had been no problems with externally funded scientists using external commitments as justification to

fail to cooperate with requests to take on time-sensitive priority research problems. However, that has to have been due to good personal relationships between staff and administration, sympathetic funding sources, and good luck. The existence of an explicit policy in advance of the first problem with a funding source unsympathetic to a government need for the same talent or equipment, allows the grant holder to address the public's need without fear of pressure or retaliation from the funding source.

An ancillary issue came up in discussions with regard to external funding. The suggestion has been made a number of times that as a matter policy CCEHBR should provide its "science on demand" service on a **pay-for-service** basis. Several staff expressed opposition to this suggestion, and the Review Panel sees merit in their view. One of the strengths of CCEHBR is that it is perceived as non-partisan by diverse and sometimes mutually antagonistic clients; the neutral "fair broker" of fact and interpretation on sciences issues, particularly science applied to societal choices. A fee-for-service policy would harm at least the perception of such neutrality, when those paying fees were on one side of a debated issue. The Review Panel encourages continued and even escalated efforts to make sure that cost recovery gets due consideration whenever CCEHBR expertise and services are made available outside NOAA. However, it supports continuation of the practice of making CCEHBR expertise available on the basis of scientific need and the match between needs and CCEHBR services, and to not discriminate, in the first instance, on the basis of ability to pay.

Another aspect of the external partnerships that pervaded all lines of CCEHBR to some degree was the absence of a **clear mechanism for deciding when and how the science knowledge and services are provided to outside interests**, whether in other parts of NOAA, other federal agencies, other levels of government, academia, and even the private sector. In other words, there are no clear criteria on which to evaluate whether or not a request for support in addressing a research problem or an environmental crisis will be granted. Some of these external partnerships have been very successful, such as the harmful algae research group's collaboration with a diverse science team on a California marine mammal die-off, and the collaborative work on new parasites in Great Lakes invertebrates. Although some collaborations are direct results of formal NOAA arrangements among programs, others seem to have occurred semi-opportunistically, based on informal networks among professional colleagues. Without trying to weaken such professional networks, there should be some process to ensure that when there is a need for the types of expertise located in CCEHBR, those needing science support know about the Center. Correspondingly, when requests for science services from CCEHBR are needed, the criteria on which the decision to help out or not is made should be widely available. Thus, if the requests for CCEHBR services increase, either due to greater publicity of CCEHBR's services or more coastal and oceans crises, the criteria for screening and ranking them are explicit and the process becomes more transparent. Such a process might also contribute to reducing the perception – and possibly the reality – that some groups within CCEHBR are overly focused on local or near-regional issues. CCEHBR is a national center with strengths, as noted above, that are unique within

NOAA. Although geographic proximity will always be a factor in where CCEHBR knowledge and services are provided most quickly and often, it should be only one of several factors.

CCEHBR was transferred from NMFS to NOS three years ago. CCEHBR staff and administrators feel that NOS is a more appropriate **organizational location** for their expertise, and the new situation has prompted some consolidation and sharpening of foci. The fit is better in NOS than NMFS, but it is not yet perfect. In particular, there were questions within both the Review Panel and among some staff in CCEHBR regarding the extent to which NOS actually has a commitment to fundamental research, intended to discover new knowledge, in addition to providing coastal ocean services to clients. NOS has endorsed a research presence in its strategic documents, but at an operation level it is sometimes hard to see the commitment in practice. There was some discussion of the possible merits of moving CCEHBR to OAR, where the commitment to basic and applied research is clearly visible in text and actions. On the other hand, the OAR commitment to providing services of the nature provided by CCEHBR in its "science on demand" identity is comparably questionable. Both the Review Panel and the CCEHBR administration believe that the service component of CCEHBR science is crucial, and is an argument for keeping CCEHBR in NOS. However, for the Panel to endorse the present organizational location of CCEHBR, NOS must make a stronger commitment in actions and funding to support science for discovering new knowledge as well as applying that knowledge to the problems of coastal ecosystems and coastal communities.

Publications are always one informative index of scientific productivity. The Review Panel concluded that CCEHBR staff have produced many worthwhile papers. Some are fundamental contributions in their field. Because of the nature of the research in some groups, many papers are benchmarks on methods for field or laboratory assays, and as such are very widely cited. However, production of publications is strongly skewed among researchers, and a portion of the permanent staff must be given more incentive to publish their results. This may be particularly the case for researchers in Branches now strongly focused on developing new techniques, biomolecular and genetics markers, etc, where there is strong competition with other research institutions and a physical product is to be produced from the research. In such cases concern to generate the physical product may be coming to dominate over producing the scientific publications, and staff in these areas need to be encouraged to keep publications more centered in their priorities.

Publications are not the only measure of scientific productivity. The Review Panel took note of the many other ways that the scientific staff disseminates their results. This includes many prominent involvements in professional societies, symposia, and meetings of scientists. It also includes a number of effective community, regional, and national committees, working groups, and other for a dedicated to application of science results to environmental problems. In these areas CCEHBR staff perform important services and have clearly earned widespread respect from colleagues, community leaders, and citizens.

A noteworthy shortcoming of the total research community at CCEHBR is the weak representation of **social sciences**. The social sciences are not an equally good complement to every component of CCEHBR, but they are unquestionably germane to protecting coastal environmental health and to at least the application of some results of biomolecular research. The Review Panel recommends that priority be given to forging greater collaborative links to social scientists in academic and government centers in the region. These partnerships with social scientists should be planned and structured, just as many of the existing partnerships with natural and physical scientists outside of CCEHBR are. The Review Panel would like to stress that this recommendation is not meant as a criticism of the commitment to community outreach that is going on now. Many researchers show both a talent and commitment to working with communities. However, social sciences are more than community outreach. Partnerships with social scientists can make new classes of problems of coastal environmental health tractable as research questions with answers that can be generalized and applied. This can be a great value added to the time currently invested in transmitting research results from CCEHBR to communities.

A structured and formal peer review and advisory process is nearly universally utilized for the application of science to management of exploited living marine resources. A similar culture of provision of scientific advice through a formal review and advisory process has not developed in marine habitat and environmental health research, but in many parts of the world the need for such a process is becoming recognized. As visibility and accountability of management decisions to sustain healthy coasts increase, greater attention is being given to the diversity of scientific opinion on risks, alternatives and their consequences, and associated uncertainties about scientific information. Given CCEHBR's mandate and stature, it would have a natural leadership role in developing appropriate processes for open and transparent conduct of objective peer review and provision of reliable, integrated scientific advice on coastal environmental health. Such peer review and provision of advice would not be intended for small, case-specific habitat decisions or emergency responses to sudden crises. However, the processes could come to have as important role in environmental health topics like identification of stressors and their interactions, selection of indicators of ecosystem status, risk analysis of vulnerable coastal sites and processes, and criteria for selecting mitigation measures.

Researchers from CCEHBR brought a number of suggestions of their own to the Review Panel, with regard to directions in which they felt the Center should move, and opportunities they felt should be pursued. Researchers repeatedly stressed the need for stronger commitment to **longer-term research**. While justifiably proud of their ability to adjust to changing NOAA and NOS priorities, and respond quickly to new crises, an important part of achieving the NOAA and NOS mandate requires continuity of research and monitoring. The Review Panel agrees that only with long-term monitoring and continuity of experimental regimens can the complex consequences of stressors and the interactions among them be quantified and understood. Likewise the sensitivity and

robustness of indicators of ecosystem health can only be tested on long and comprehensive data sets, arising from long-term research and monitoring. It is an established principle that government laboratories are better positioned and more suitably organized to conduct long-term monitoring than are universities or private laboratories, and that is particularly true for marine and coastal ecosystems. Such programs would fit very well within CCEHBR.

Another opportunity that was mentioned several times was the possibility of building a strong program in **marine and coastal eco-criminology**. As legal protection of coastal environments is strengthened, and court-imposed settlements become more costly, the need to demonstrate culpability for environmental damage increases. Existing CCEHBR strengths in marine forensics, molecular and biochemical markers, eco-toxicology, and indicators of environmental health could be combined into a leading program in support of legal actions to protect coastal environmental health and punish violators of environmental protection measures.

MARINE ECOTOXICOLOGY BRANCH

The Marine Ecotoxicology Branch comprises four research programs in contaminant chemistry, environmental microbiology, toxicology and environmental modeling and assessment. The first three programs conduct fundamental investigations into their respective areas, while the fourth integrates the knowledge gained from these studies and also from the larger research arena conducted outside of NOAA. The mission statement of MEB is:

> *"The MEB's mission is to conduct interdisciplinary, ecological and toxicological research focused on identifying chemical, physical and biological contaminants associated with urban development, agriculture, dredging operations and industrial discharges, and their resulting impacts, from a molecular to an ecosystem level, on marine, coastal and estuarine ecosystems of the United States"*

Current personnel of MEB are 37 employees (15 FTEs, 8 contractors and 14 funded university collaborators and graduate students). A position is currently open for a Ph.D. chemist position to be held jointly between NOAA and South Carolina Department of Natural Resources (SC-DNR).

Summary of Research Programs

Contaminant Chemistry (CHEM)

CHEM provides analytical chemistry capabilities and services for all of MEB's research programs as well as the other research branches at CCEHBR, other parts of NOAA, other federal agencies and research partners at state agencies and universities within the region. Capabilities include capillary gas chromatography with a number of detection systems (electron capture, nitrogen-phosphorus, mass spectrometry: GC-ECD, GC-NPD, GC-MS), inductively coupled plasma mass spectrometry (ICP-MS) and atomic absorption spectroscopy (AAS) for metals, and mono/polyclonal antibody detection systems. Activities of the program include:

- Routine analysis of trace metals, PAHs, organochlorine and modern pesticides, and PCBs in a variety of matrices: air, water, sediment, biological tissues.
- Development of new analytical methods for new compounds of interest, including pharmaceutical drugs in the environment.
- Sampling air and water, including use of semipermeable membrane devices (SPMDs) for water.
- Participation in NIST interlaboratory calibration exercises.

Environmental Microbiology (EMB)

EMB examines microbial pollution of coastal waters and organisms, particularly in connection with shellfish harvesting and seafood safety. Activities of the group involve:

- Identifying sources of fecal coliform pollution such as septic tanks, sewage treatment plants and chicken/hog farms in estuaries. This research is part of the Urbanization in Southeast Estuarine (Eco)Systems (USES) and Land Use Coastal Ecosystem Study (LUCES) projects and projects with South Carolina Department of Health and Environmental Control (SC DHEC) and the state of North Carolina. Findings are integrated with CCEHBR Land Use Coastal Ecosystem Study (RAIM) researchers addressing seafood risk analysis issues.

- Investigation of the introduction of invasive *Vibrio parahaemolyticus* and other *Vibrio* bacteria species from ballast water into Charleston Harbor and other coastal regions of South Carolina. Studies include determining levels of these bacteria in shellfish and in ballast water from ships entering ports of commerce in the Atlantic and Gulf Coast regions. Vibrio antibiotic resistance patterns are compared to antibiotic usage patterns for the country of origin. As above, research is integrated with the RAIM group.

Toxicology (TOX)

TOX is directed toward understanding the effects of environmental contamination and perturbation on estuarine and marine ecosystems.

- Bioassays are conducted on whole organisms ranging from bacteria to fish at single animal, population and community levels.
- A wide variety of sophisticated sublethal endpoints are examined: respiration rate, growth and reproduction, biomarkers (e.g., EROD), community alterations, and lipids composition.
- Research is focused on contaminants associated with urban development, golf courses, vector control, agriculture, polyaromatic hydrocarbons (PAHs) and their UV activation associated with Superfund sites and dredging operations.

Environmental Modeling and Assessment (EMA)

The EMA group models toxicological and microbiological effects and contaminant chemistry associated with urban development of watersheds. A long-term goal is to develop predictive contaminant loadings, biological effects and water/sediment quality models. Specific focus is placed on those areas of the environment specified above in the EMB and TOX sections. Modeling development includes the use of:

- Geographic information systems (GIS)

- Hydrological modeling
- Ecotoxicological water/sediment quality modeling

Program Evaluation

Quality of the Science

Contributions and Uniqueness of the Branch
MEB conducts research oriented to urban and agricultural impacts on coastal estuaries. The work is done collaboratively and cuts across other Branch programs. Some numerous specific studies are:

- USES and LUCES (see above)
- Agricultural Runoff in Estuarine Ecosystems (ARIES)
- Endocrine Disrupting Chemical (ECD) Effects on Crustaceans
- EPSCOR study in which estuarine mesocosm toxicity testing units were developed and applied
- Contaminant Chemistry in Marine Mammals
- Pharmaceutical Drugs in the Environment
- Florida Bay – South Florida Research
- Superfund Site Research
- Sustainable Seas Expedition to investigate transport of atrazine to coral reefs in the Gulf of Mexico and South Atlantic.

A unique feature of the branch is their ability to carry out integrated toxicity studies from the molecular to ecosystem level. In the course of these studies, the branch has developed many innovative approaches:

- Development of integrated coliform source identification tools such as Multiple Antibiotic Resistance (MAR), Ribotyping (RT) and Coliphage analysis.
- Deployment of antibody test kits to measure pesticide levels in surface water throughout South Carolina and the Gulf of Mexico, including verification of results using traditional analytical methods.
- Development of a Laboratory Information Management System (LIMS) within CHEM.
- Designing and applying *in situ* bioassays, using fish and grass shrimp, to determine toxic effects of pesticides from agricultural runoff and physical disturbance due to dredging operations.
- Designing and constructing mesocosms to study effects of chemicals and their interaction with physical changes (e.g., temperature, salinity) at a community level.

- Developing methods to integrate basic toxicological, chemical contaminant and microbiological data with GIS land use data into predictive models of impacts on land use in the southeastern U.S.
- Development of bioaccumulation models for pharmaceuticals to shrimp, the first study to document substantial uptake of oxytetracycline.
- First spatial statistical model to predict natural resource impacts from docks and bulkheads.
- Development of a four-point cumulative risk reduction strategy for agricultural non-point source runoff: a) formation of a coastal pesticide advisory, b) integrated pest management, c) selection of less toxic and persistent chemicals and d) use of retention ponds.

Publications

The tabulation of publications provided to the Panel was incomplete and difficult to break out by research group or type of journal, but it was apparent that publication rate is highly skewed. Although a couple of team leaders have published extensively, a number of researchers appear to have published infrequently. Even when the objective of a research project is development of a method for field (sometimes commercial) application, publication of results in scientific journals, monographs, and other referees series must be made a priority for all staff. In addition to a number of book chapters, publications are scattered among over a dozen journals, with most articles in *Environmental Toxicology and Chemistry* (9), *Aquatic Toxicology* (4), *Archives of Environmental Contamination and Toxicology* (3*), Bulletin of Environmental Contamination and Toxicology* (3). Several book chapters are among the contributions, including one in a 1999 volume from the SETAC Pellston Workshop on *Ecological Risk Assessment for Wetlands* and three in the Belle W. Baruch Library of Marine Science volumes. Several publications stand out as highly significant contributions to the field, and are widely cited.

Graduate Student Work Within MEB and Collaboration with Universities

MEB has forged partnerships with several universities in South Carolina. The Branch also emphasizes involvement of graduate students in research projects. Between 1996-2000, 20 M. Sc. Theses and 20 Ph. D. dissertations were produced by students working with scientists at MEB. Numerous awards were given to these students for excellence in presentations and research on a regional and national level. Examples are given in the MEB Self Evaluation section.

Several staff hold appointments at Regional universities, including, in various combinations University of South Carolina, Medical University of South Carolina and/or University of Charleston (Scott, Fulton, DeLorenzo, Siewicki, Bearden, Key, Wirth), and Clemson University (Wirth). Extensive courses in aquatic and environmental toxicology have been taught at these institutions by branch staff. A large number of

coastal studies have been done in collaboration with scientists at universities. Collaborative efforts on public health with NOAA were cited as a strength in the 2001 accreditation review of USC's School of Public Health.

Other Indicators of Scientific Merit

- Research on coliform identification was one of 20 presentations selected by the American Society of Microbiology to be highlighted at a press release from the 1999 annual meeting.
- Many research grants, totalling $4.0M from 1996-2000, have been awarded to MEB from external sources from 1996-2000. Total grants to MEB and its research partners totalled $11.2 M.
- A highly competitive EPSCOR award was made to MEB, with MUSC partners, to develop mesocosm toxicity testing units for environmental scientists within the region.
- Awards have been made to staff: the Dialog III award from American Society of Limnology and Oceanography (DeLorenzo), selection of Fulton as the Federal Employee of the Year in the Scientific Technical Category for the Charleston Area, and Bearden as a finalist in this competition.
- Selection of branch staff to serve on EPA's Science Advisory Boards for EDCs and the Advanced Environmental Technology Verification Program, as the NOAA representative on the interagency panel for EDCs, and as an editorial board member for the journal Aquatic Toxicology.
- Strong relationship with NIST ensures a high degree of quality assurance. CHEM is the only NOS/NOAA laboratory involved with interlaboratory calibration exercises for all three study matrices (sediment, tissue, blubber).

Significance and Impacts

The MEB Self-Assessment states **"The major significance of branch research is that it enables managers to define impacts from coastal development and to develop risk reduction strategies to minimize or eliminate environmental hazards. This process translates into Sustainable Coastal Development"**. The Panel concurs that Branch studies and research products have found high usage among the many agencies in the southeast that are responsible for protection of the coastal zone. A very significant accomplishment has been application of the branch's Cumulative Risk Reduction Strategy for mitigation of pollution due to agricultural non-point source runoff. This approach has resulted in an 89-90% reduction in pesticide loadings to estuarine tidal creeks in South Carolina, and fish kills have been substantially reduced. These approaches have been applied to similar agricultural problems in Virginia and Florida.

Research done within EMB has resulted in zoning changes or environmental management decisions regarding water quality issues. Advances due to EMB research include identification of septic tank leakages, identification of specific types and sources

of microbial pollution in impaired watersheds, finding the sources of bacterial pollution sources near Hilton Head, development chemical contaminant databases for sediments and oysters that serve as benchmarks for assessment of contamination due to coastal development and define levels for a "Healthy Coast", detecting pesticides in agricultural runoff to the Everglades, and development of multivariate tools for including coastal environmental quality with Regional planning. Many of these projects have resulted in more cost effective monitoring, improved zoning and planning on watershed and coasts, and better regulatory regimes and community ordinances, taking the benefits of projects well beyond the site(s) at which the work was conducted

Branch Strengths

MEB's strong points include:

- High quality of science, very strong interdisciplinary research ranging from the molecular to ecosystem level.
- Ability to integrate across programs and among branches.
- Outstanding record of collaborations partners and success in obtaining extramural funding
- Strong partnerships with universities through faculty appointments, educational outreach programs and mentoring of students.
- Outstanding leadership in coastal pollution and land use issues and ability to turn basic and applied research into plans of action.

Other points mentioned in MEB's self-evaluation are a high "esprit de corps" among staff, high level of education of staff members, and diversity of research experience.

Branch Weaknesses

The Panel concurs with several points raised in the MEB self-evaluation document, including:

- Lack of federal FTE positions for junior level staff; many are on contractual arrangements.
- Lack of advancement to Senior Level Scientist (GS15) and lack of predictable career advancement.
- Lack of training for junior staff that enter supervisory positions.
- Reliance on extramural funding, requiring substantial time spent "chasing money" rather than conducting research.
- The "rust-out phenomenon". Some of the analytical and field equipment is old and needs to be replaced in the near future. Lack of a formal program to replace equipment on a regular basis is a weakness within MEB and indeed the whole of CCEHBR.

The Panel notes improvements could be made in some other areas, including :

- Number of scientific publications, from staff other than the two or three "high-liners" in the Branch.
- Targetting of publications in more mainstream environmental or agricultural journals such as *Environmental Science and Technology, J. Agricultural and Food Chemistry, J. Environmental Quality* and *Environmental Pollution*, in addition to the three or four quality journals now favored by the Branch scientists.
- The MEB research program lacks an atmospheric component. The coastal region receives atmospheric loadings of pollutants that should be taken into account in field and modeling studies.
- Additional efforts could be made in the area of chemical modeling, using the "fugacity" type models that have been successful for describing bioaccumulation and sediment-water-air interactions. Other models that could be useful in the ARIES program are those used to estimate soil-to-air exchange of pesticides.
- The branch could do a better job of selling itself, nationally and internationally. MEB successes should be made more available. For example:
  a) Many of the issues related to pesticides in the southeast are also issues in California (e.g., pesticide runoff into the San Joaquin River) and the Cumulative Risk Reduction Strategy may be very useful there.
  b) There is a lack of involvement with similar programs in the mid-Atlantic region, such as; USDA in Beltsville studies of pesticide runoff in the Wye River and other estuaries, Stroud Water Research Center (Philadelphia) use of molecular markers to trace fecal and other pollution, and contaminant programs are at Virginia Institute of Marine Science and Chesapeake Biological Laboratory (Univ. of Maryland).
  c) The levels of international involvement also seems to be low, yet here is a "flagship" program that should be touted at every opportunity!

Concluding Remarks

At the present time, CCEHBR (including MEB) has a very strong tradition of linking basic and applied science and communication to stakeholders, which has resulted in a number of tangible benefits to environmental quality throughout the southeast. These benefits have derived from applying "sound science" and predictive modeling to environmental policy and management decisions.

PATHOBIOLOGY BRANCH

1. Mission Statement

To provide science based answers and tools needed to address problems impacting the health of coastal ecosystems and resources

2. Serving the scientific needs of NOS

The Pathobiology Branch has long been and is currently renown both nationally and internationally for its expertise in research on invertebrate pathology. Their goal is to maintain this fundamental expertise in invertebrate pathobiology while improving their ability to rapidly respond to emerging coastal health issues impacting valuable resources. Oysters, clams, crabs, and shrimp are among the most heavily exploited coastal species. Their health and the health of other flora and fauna are vital to supporting the integrity of the marine ecosystem. Knowledge of invertebrate biology and pathology is critical to understanding the processes that sustain healthy coasts. Diseases and other stressors cause major losses of ecologically and economically important species and contribute to decreased species diversity. For example, blue crab populations along the Atlantic coasts have been greatly reduced by diseases caused by parasites and other pathogens. Water quality declines with the loss of important filter-feeders including bivalve mollusks and other shellfish. Critical habitats for hundreds of plant and animal species along the Atlantic and Gulf coasts no longer exist with the loss of oyster reefs and other biogenic marine habitat structures. Pathobiology Branch scientists possess specialized expertise and training (e.g. histology, microbiology, electron microscopy, and parasitology) needed to diagnose disease, identify and culture pathogens, and assess important host/pathogen interactions needed to improve diagnostics. They are uniquely skilled to apply a multi-disciplinary approach to understanding the causes and effects of disease on marine invertebrate populations with their knowledge of biology, ecology, oceanography, and marine biology.

3. Organizational setting inside NOS

The Pathobiology Branch of the Coastal Center for Environmental Health and Biomolecular Research (CCEHBR), in Oxford, MD, employs 4 scientists, 2 technicians, and 4 administrative staff. It is a NOAA laboratory (the only CCEHBR branch not located in Charleston, SC) operated by cooperative agreement with the Maryland Department of Natural Resources (MD DNR). For nearly 40 years the pathobiology program had been associated with the National Marine Fisheries Service (NMFS). During the last 5 years the program at Oxford has been reassigned several times to various administrative units within NOAA from NMFS Northeast Fisheries Science Center to the NMFS Southeast Fisheries Science Center, and most recently to CCEHBR.

Administrative mandates through this time focused research projects on service oriented research to meet client needs.

4. Local, regional, national, and international activities.

Local activities support the needs of NOAA, the Chesapeake Bay Program, and a Cooperative Agreement with the MD DNR (e.g., study of the health of clams, oysters, and crabs within the Chesapeake Bay). Studies involving non-indigenous species support the transfer of information from the national program to the local program.

Regional activities address needs of researchers and managers in the Maryland DNR and the Virginia Institute of Marine Science. Experts in crab diseases support many state management programs along the Atlantic and Gulf coasts through diagnostic training and disease verification. Experts in other invertebrate diseases support other state laboratories in the development of diagnostic methodologies and technology transfer.

Nationally, information on disease and animal health is used to develop management programs to prevent the introduction of potentially destructive non-indigenous species. Many states are assisted in training and diagnosis of disease problems. Expertise is provided to federal agencies including the USDA, FDA, and EPA to address problems affecting animal and human health issues (e.g., *Cryptosporidium* in shellfish from agricultural sources with USDA, disease introductions under the National Shellfish Sanitation Program of the FDA).

International activities include joint investigations with scientists at the Spanish National Reference Laboratory to control a pathogenic parasite found in clams of Europe and the Chesapeake Bay. Expertise on clam parasites is provided to laboratories in Portugal, and as requested by Canada and Japan

5. Setting priorities

The highest priorities are problems that are clearly national in scope or multi-jurisdictional, or issues of concern to other NOAA or NOS programs. Research takes three distinct approaches: study of the disease in the field (epizootiology), development of diagnostic techniques, and clinical (experimental) study of disease in the laboratory. The goal of each approach is to provide managers with the science-based understanding and tools to mitigate the impact of disease on coastal resources.

6. Major clients, connectors, scientific community

Clients of the Pathobiology Branch extend from watermen, who suffer poor yields of shellfish resulting from a variety of diseases, to managers with large scale disease issues involving invertebrate species. The Branch interacts with universities, and mutually

supports a variety of state and federal agencies. The Science Review identified over 200 cooperators.

Staff members are often requested to serve on NOAA, Saltonstall-Kennedy, and USDA research panels and as reviewers for scientific journals and books. They have served as officers in national scientific organizations, have been requested to organize and chair sessions for national and regional scientific meetings including the Aquatic Nuisance Species Task Force, Society of Invertebrate Pathology, Eastern Fish Health Workshop, National Shellfisheries Assoc., and the International Symposium on Pollution Responses in Marine Organisms. They serve as NOS and NOAA representatives on science work groups such as the Aquatic Nuisance Species Task Force, Marine Biotechnology Working Group, the Microbe Project Interagency Working Group, and the working group to assess the Long Island Sound Lobster mortalities.

Members of the branch serve on the National Aquatic Nuisance Species Task Force (ANS), the ANS Risk Assessment and Management Committee, and the Chesapeake Bay Exotic Species Work group. They also serve as chair of five associated ANS committees. In these capacities they have been strongly involved with the ANS risk analysis review process for newly introduced species and the publication of reports that assess the impact of shrimp viruses, Black carp, Asian swamp eels, Florida sturgeon and soon the Asian snakehead as well as the intentional introduction of two exotic oyster species into Chesapeake Bay. This work is of national and international importance that serves federal, state, university, tribal, and public interests.

Examples of recent major collaborative initiatives and associated accomplishments include:

- Branch scientists worked closely with USDA, Johns Hopkins University, and the Center for Disease Control partners to design and implement research on waterborne human pathogens *Cryptosporidium* and *Giardia* in estuarine water, shellfish, and sediments. Accomplishments include:

  Twelve (12) peer reviewed publications.
  Keynote speaker for the American Society of Tropical Medicine and Hygiene.
  Keynote speaker at the Interstate Seafood Seminar.

- New England states and aquaculture industry clients requested Branch scientists to investigate the cause of a new disease (JOD) affecting shellfish and provide management recommendations to the northeastern U.S. shellfish industry. Accomplishments include:

  Demonstration that the agent was transmissible.
  Identification of parameters that affected disease onset, interrupted the disease process, and led to successful management applications that control the disease.

Invitation of two scientists to present their findings to two international groups, the International Workshop on Shell Diseases in Marine Invertebrates in France and the US-Japan Cooperative Program in Natural Resources in Japan.
Six peer reviewed publications and funding agency reports were generated by this work.

- Results of Branch cooperation with Great Lakes Environmental Research Laboratory (GLERL) and Canadian scientists on tumor-like anomalies on copepods from Lake Michigan include the following:

  Branch scientists found anomalies were a combination of herniated host tissue and parasites.
  EPA awarded a grant for $17.5K
  Several disease-causing organisms were found in amphipods.
  Findings were published in the Canadian Journal of Fisheries and Aquatic Sciences.

- Staff research on the crustacean disease *Hematodinium sp.* has led to close cooperation with MD, DE, and VA resource managers, Virginia Institute of Marine Science, and Skidaway Instituteof Oceanography to address blue crab diseases in Atlantic coastal bays. Accomplishments include:

  Five (5) peer reviewed publications resulted from these studies.
  Improved diagnostic techniques developed in collaboration with Skidaway Institute.
  Serving as an advisor to the Maryland Coastal Bays Management Council.
  Design of a sampling program and provision of technical support to MD DNR Coastal Blue Crab Studies

- A new *Perkinsus* parasite found in clams was associated with the decline of clam populations in Chesapeake Bay. A series of collaborative investigations by Dr. McLaughlin with VIMS, USDA, FDA, Cairo University, and CSIC/Spain scientists led to major accomplishments:

  In vitro propagation of two clam *Perkinsus* spp.
  Description of a new species: *P. chesapeaki*
  Development of an improved diagnostic assay
  First report of multiple *Perkinsus* species infections in one host species
  Four new gene sequences deposited in GenBank
  Publication of eight (8) peer-reviewed papers
  Presidential Early Career Award ($50K)

- Histological, biochemical and immunological investigations on clam sarcomas were conducted in collaboration with VIMS, Cairo University, and NMFS. Accomplishments include:

  Discovery of novel defensive molecules in clams
  First report of sarcomas in New Jersey clams
  Publication of 2 peer-reviewed papers

- A new research project is being developed on coral diseases with Mote Marine Lab, Living Oceans Foundation, and NOAA partners. The Pathobiology Branch is developing a new international registry and repository for coral pathology for the Coral Disease Health Consortium. Forty years of invertebrate pathology expertise makes Pathobiology Branch scientists uniquely qualified to investigate the unknown etiologies of diseases devastating coral reefs worldwide.

7. Overall Evaluation

The board finds that Pathobiology Branch science is of exceptional quality and is unique within NOAA. However, it appears that the expertise and national importance of the Branch has neither been recognized nor adequately supported over the last five years. Funding and vital scientific staff positions have been lost through administrative actions within NOAA. The science review identified a lack of long-term line office or agency-wide research projects or lack of agency support for this group. The review also identified unfilled critical research staff positions, vacated through retirement and inadequate funding to hire replacements. Funding losses have prevented the updating of old equipment which has had negatively impacted Branch research. To obtain funds to support research priorities scientists have had to "piggy back" research onto other projects or funding sources. As a result they do not become senior authors in research publications and they, the Branch, and NOAA lose recognition and stature**. The need to increase in-house funding and fill vacant positions is of critical importance to maintaining a viable aquatic disease program. Because our nation is experiencing a dramatic rise in aquatic diseases of environmental and commercially important species the importance of the Branch program to NOAA has increased greatly**. **These deficiencies need to be addressed by NOS and NOAA or this unique NOAA program will be lost**.

COASTAL RESEARCH BRANCH

OVERVIEW

The NOS Center for Coastal Environmental Health and Biomolecular Research at Charleston, South Carolina has over the last 10 to 15 years developed an internationally and nationally recognized expertise in the field of harmful algal blooms, their toxins, and associated natural resource and public health impacts. The Coastal Research Branch (CRB) and Center administration have set this lead. The success of CRB in part is due to its personnel and their ability to form collaborative partnerships. This is a unique and effective program within the federal government that does not exist elsewhere.

The quality of the science in this Branch exemplifies the highest standards of science; specifically "credible, reliable, and respected science". The direction and responsiveness of the science supports decision-making in regards to natural marine resource and public health issues. Such issues include detection of diverse perturbations of marine systems and identification of appropriate responses, in areas of public and health safety with seafood, potential environmental threats to public health, and threats to the health of living marine resources. Obviously, the science that supports decision making also supports policy development, e.g., policies on seafood safety, policies on endangered marine animals, and policies on aquaculture and fisheries management.

MISSION

The mission statement for this Branch arose from a workshop of scientists and managers in 1992 organized by the Center. The workshop results became the "National Plan on Marine Toxins and Harmful Algae" and NOAA initiated the Marine Biotoxins Program. Statement: "**The Marine Biotoxins Program provides scientific guidance and directed research to promote effective management of living marine resources, ecosystem health and public health on issues involving marine toxins and harmful algae".** This mission is in agreement with the NOS and NOAA mission statements.

PROGRAM

The core of the CRB is the Marine Biotoxins Program with 26 personnel and 11 defined research activities from international and national significance to local significance. This program exemplifies how the most successful research spans a full continuum from basic to applied research in an integrated manner. In the Marine Biotoxins Program the basic research often involves Technological Development; in this case of methods and protocols or refinement of techniques for detection of specific substances or conditions. The applied surveillance and assessment activities of MBP and the users of its products are built on the results of the technological developments. The work of BRP along the full continuum is needed to accomplish long-term goals as well as long-term research,

and both are needed to create the database for assessment and making decisions and formulating policies on coastal resources.

The Marine Biotoxins Program as the main emphasis of the CRB has an integrated program of biotoxin detection, characterization and quantification in different matrices including seawater and marine animals, e.g., marine mammals, sea turtles, fishes. The Program has four disciplines - taxonomy, molecular biology, chemistry, and toxicology. With this capability, the group is able to assess fate and effect of biotoxins or phycotoxins in the food web and environment. The above capability also provides the ability to research and identify new toxins and new resource threats. Other program aspects include researching the termination or demise of harmful algal blooms to determine the mechanism and investigate potential control measures. The MBP research has national and international significance, and has resulted in partnerships with private, state, academic, and other federal groups. The program also partners at the local level within the state of South Carolina, and has established a monitoring network using volunteers.

PERSONNEL

The core team has five senior scientists, 10 scientific staff, and 11 students and postdoctoral fellows in training. In a profile of staff by Branch, the CRB had a disproportionate percentage of contract staff compared to the other branches. As discussed in the overview of the Center itself, reliance on contract employees and students presents challenges. One of these challenges is maintaining trained personnel as career employees and thus maintaining the corporate knowledge and expertise. However despite this difficulty, the program is exemplary in providing opportunities for training in this field of science and at the same time providing opportunity for diversity.

QUALITY OF SCIENCE, SCIENTIFIC MERIT, AND SIGNIFICANCE

As noted in the overview the science in this Branch exemplifies the highest standards of science, with results that are “credible, reliable, and respected”, and effectively supports decision-making and policy-setting in areas of natural marine resource and public health issues. The quality and effectiveness of the science is apparent in a number of indicators.

Publications

Between 1996 and 2001 publications by CRB staff represent about 30% of all publications from CCEHBR. Although a Citation Index search was not, the Review Panel was confident that such a search would reveal that their published work is cited frequently by other scientists and by managers. Many of their publications are industry benchmarks for field and laboratory techniques, whereas others are examples

of particularly well-integrated research.

Partnerships

Other supportive information for the significance and need of the science is the type and number of collaborative partnerships established.

- 12 South Carolina partners
- 56 national partners
- 22 international partners

Technology development and transfer is a cornerstone of several federal initiatives and applies to the CRB. For example, personnel have trained others in the US and foreign countries on how to detect and quantify specific toxins so their surveillance programs provide greater protection for public health. Training is only one type of partnering. Another is being a significant partner in identifying the cause of major marine resource catastrophes, such as the sea lion mortality in California in 1998, where CRB staff pinpointed the trophic pathway of the toxin involved. Still another is that CRB has the capability of mass culture of toxic microalgae and the ability to purify toxins for standards. These standards can be used for a variety of research and monitoring programs such as the development of probes for detection of toxins in different matrices.

The CRB is regularly requested to assist in responses to HAB events and in doing so has helped identify the cause of specific mortalities. This responsiveness is a service, but a service that is based on continued basic and applied research where techniques were developed and are continually refined based on new information. An example of the benefits of such integrated basic and applied research is the increased ability to assess the significance of metabolized toxins and their byproducts in the fate and effects of toxins in the food web. CRB scientists are able to take the technology for detecting toxins and their metabolites and apply it to research programs that address the origin, fate, and effect of biotoxins in the marine environment, in long-term research programs with phase completion stages.

CRB scientists have worked in Maine on PSP and DSP issues, in the mid-Atlantic and southeast on identifying *Pfiesteria*'s toxin, in the Gulf of Mexico to understand the fate and effect of brevetoxins in the food web, as well as several different areas on ASP and its fate. Such collaborative science has required new techniques or modifications of techniques. Staff of the CRB have also emphasized the need to identify and know toxin congeners and toxin metabolites, particularly in animal tissue.

Peer and Client Review

Peer review of the CRB programs and focus is a continuing activity that occurs via published papers, conference presentations and workshops, collaborations, and outside funding. Review of the program is also a continuing effort of the CRB staff in its regular sit-down meetings and evaluations. In addition, staff of the CRB are responsive to user or customer needs. This is exemplified by the development of blood collection cards for the simple collection of material for biotoxin analysis that can be done anywhere under any conditions. The cards have the advantage of making sample collection simple, allowing the storage of toxins in dried blood on cards that can be shipped in regular mail, and the cards can be processed back at the laboratory with rapid extraction and a screening procedure. This was a new product for diverse customers in state agencies, federal agencies, and private laboratories. The end user was in real need of a rapid method of screening that was simple.

BRANCH STRENGTHS

It is clear that the CRB is a core part of CCEHBR, sharing its strengths in sub-organismal research at the molecular and cellular levels in support of NOAA's mandate. The main strengths are its staff and their approach to sound science in support of sound, science-based decision-making. In addition, the Branch provides excellent training to students and provides technology transfer to scientists and managers at the national and international level. The transfer is not the end of the association because guidance is continually provided. The senior scientists and research scientists are well known within the scientific community and are sought after as co-investigators on harmful algal bloom or phytotoxin projects, e.g., Ecology and Oceanography of Harmful Algal Blooms (ECOHAB).

CRB staff are able to provide emergency response for a HAB event and are sought for not only initial screening to identify the problem but for final identification of the biotoxins involved. Their flexibility and creativity are remarkable. Again, it should be emphasized that this is a unique and effective program within the federal government that does not exist elsewhere. The value of identifying species and their toxins is in then being able to determine what the public health and living natural resource threat are, and take the necessary actions.

BRANCH WEAKNESSES

Weaknesses in the program result from trying to serve several masters, not beng able to increase FTEs and maintain expertise, and problems replacing old or obsolete equipment,

and purchase new equipment. Lack of FTEs is a particularly severe impediment, because contract workers and trained professionals move on to other positions with more benefits. It is not known how the new Hollings Marine Laboratory will help with the availability of equipment and facilities, nor exactly what components of the CRB would be located there.

The service function of CRB may be considered a weakness in the sense that does not permit the achievement of long-term goals. First there is technology development, then verification of the technology, and then application. Through application over sufficient time, databases can be developed that could be of use in assessment of coastal resources and other resources to determine risk, predict impacts, and provide contingency plans. However, new demands for the service function arise before the long-term application by CRB staff can be established, so the long-term work must be carried on by others.

Although CRB is highly responsive to user needs, there has not been a survey of needs as identified by the user or customer. If this were done, it would probably reinforce decisions that the CRB and Center have already made regarding programs targetting particular needs, but such a review might be of value nonetheless. It might help to provide clearer choices among competing priorities, as well as focus discussion better on whether the CRB should be strictly service or whether it should be technology development, verification, technology transfer and development of long term databases.

RECOMMENDATIONS

1. Provide financial support for replacement and new equipment needed.

2. Provide FTEs for positions that are now filled by contract workers and allow vacancies to be filled when they occur.

3. Facilitate the understanding how the sub-organismal approach contributes to science-based decision-making within NOAA.

4. Identify the Center's long-term research function and capabilities within NOAA as its main function. Those core capabilities and functions would include technology development, verification, transfer and the development of long-term databases. Service would still be a component of the program, but not at the expense of the long-term functions.

LIVING MARINE RESOURCES BRANCH

The mission statement of the Living Marine Resources Branch is:

"*to provide a scientific basis for assessing the health status of marine species and for identifying the integrated effects of environmental stressors/impacts on organisms, populations, and coastal ecosyste*ms"

The programs of this Branch are focused on the assessment of health of marine organisms and determination of the effects of environmental stressors and impacts on those organisms and their ecosystems. The research targets these processes at the physiological and molecular levels, as well as incorporating biotechnological techniques to elucidate ecosystem processes and effects. There are three primary research areas: (1) functional genomics and molecular genetics, including biodiversity, species identification, characterization of gene expression to elucidate biochemical and genetic control mechanisms; (2) biomarkers for assessing ecosystem health and determining disease processes, which involves the search for new markers to indicate the presence of stressors or various types; and (3) marine mammal health assessment, which is focused primarily on the responses of the bottlenose dolphin to various stressors.

The ability to assess, monitor, and protect ecosystem health is an important element of NOAA's mission, as the development and application of sound management decisions is tightly linked with maintenance of health of environmental resources. Hence, the activities of this Branch are directly relevant to NOAA's mission. The marine mammal research is also relevant to NMFS activities and reflects the history of CCERBR's affiliation with NMFS, and yet the mammal research is clearly relevant to the stewardship component of NOAA's mission. The sophisticated molecular approaches incorporated into much of this Branch's research represent an innovative strength for CCERBR, and their synergy with other CCERBR Branch activities (e.g. forensics) probably represents a unique capacity among NOAA laboratories.

The personnel in this Branch is limited, with seven FTEs and 4 contract staff. As with other Branch's at CCERBR, a high turn-over rate of junior staff is a problem, which interferes with research progress. Laboratory personnel from other Branches contribute, but this draws them away from their primary duties. Volunteers also contribute, but training of volunteers takes staff time for training and oversight. There is a clear need for additional primary researcher positions and technician support.

The Panel was very impressed with the quality of the research, and in particular with the attempts to incorporate modern molecular tools and approaches into the various aspects of the program. It was apparent that progress was being made in the development of creative approaches to environmental assessment. In particular, the innovative research on the development of arrays of biomarkers illustrated an ability to utilize sophisticated approaches "borrowed" from the medical arena for diagnosis of organism responses to

environmental stressors. The research on coral bleaching also demonstrates the application of modern molecular approaches to complex process problems. The work on bottlenose dolphins appears to be founded on appreciable experience with these mammals and makes an important contribution to understanding the their vulnerability and responses to contaminants and stressors of various kinds.

Primary research accomplishments include the following:

- Development of molecular methods for identification of marine animal species (tunas, sharks, sea turtle, sciaenids).
- Participation in multi-institutional collaborative trials for a polymerase chain reaction-based technique for identification of the Norwalk virus in shellfish.
- Ongoing development of field diagnostics based on laboratory molecular analyses.
- Application of biomarkers that predicted coral bleaching 2-3 months in advance of visible bleaching.
- Development of risk assessment models to examine effects of stressors on marine mammal health.

This Branch disseminates information in a variety of ways. With assistance from RAIM, a Marine Mammal Information System has been developed to attempt to identify conditions related to mammal health and strandings. A video describing the issues relating to coral disease and reef degradation was produced for distribution. The numbers of scientific publications appear to be somewhat less than some other Branches (6 in FY2000), possibly because of the staff limitations or early developmental stages of some of the research. Because of the apparent high quality and significance of this research, it is particularly important that it is made accessible to the research and user community. We encourage increased emphasis on the publication of research findings and the timely dissemination of results. There appeared to be appreciable sharing of research results through collaborative relationships and participation in meetings, but increased attention needs to be paid to publication in the research literature. This not only ensures dissemination of the material, but also provides a means to ensure high quality of product through peer review.

The greatest obstacle to scientific progress appears to be researcher and technical staff needs. Some of these needs have been met through strategic partnerships, but clearly that approach has its limitations. There are enormous opportunities in the Branch, particularly in areas relating to biotechnological research. This is a major area of creative discoveries and problem solving, and with appropriate research personnel, significant strides should be made addressing a range of needs, ranging from species identification to pathogen and contaminant diagnostics. The Branch appears to be sufficiently flexible, and researchers have adapted to new technical opportunities (e.g. biotechnological approaches) and changing priorities (adaptation of mammal program following shift from NMFS). There are considerable opportunities for advancing science and for addressing

NOAA priorities, if sufficient resources are made available and attention is paid to dissemination of research results.

With the move into the new Hollings Marine Laboratory, there will be increased opportunities for partnership and integrative collaborations. Every effort should be made to take advantage of those opportunities, as this type of research can benefit considerably by interfacing with the molecular strengths of the HML partners. However, the full benefits of the HML resource will not be realized without increased staff support for the Living Resources Branch.

Specific Recommendations:

- Continue with focus on biotechnological research and creative approaches to Branch research programs.
- Address researcher and staff deficiencies.
- Take advantage of collaborative opportunities provided by HML.
- Improve dissemination of results through increased publication of original research.

RISK ANALYSIS AND INFORMATION MANAGEMENT BRANCH

The mission statement of RAIM is:

> *"to develop risk management information and predictive capabilities for use by natural resource manageres, public health agencies, commercial interests, and other partners."*

This Branch incorporates two important functions: the management of information and the use of that information for risk analysis. An important objective is to ensure that the data are managed in a way that they are available and useful for coastal management.

With data and information management, the Branch faces a common problem: getting vast amounts of data in a form for maximum utility. Particularly complex are the problems associated with databases, such as metadata format, quality assurance, and quality control. Nevertheless, staff appear to recognize these difficulties and the need to find solutions to streamline data management and utility. Partnerships are particularly important here, as these are common difficulties and common solutions are necessary for effective information transfer and shared use. Examples of such partnerships include:

- State and federal linkages (EPA, FDA) for the SIMS database.
- EPA, FDA, coastal states, and the Interstate Shellfish Sanitation Conference in formulating management actions related to risk assessment in coastal systems.
- The Cape Romain Ecological Characterization utilizes protocols established by the National Estuarine Research Reserve System

This Branch also provides the expertise required for the CCEHBR's computer services and infrastructure. This is clearly an essential service, and it is important to maintain sufficient personnel and resource support.

The risk analysis effort is focused on four areas: (1) shellfish pathogens risk reduction; (2) national shellfish information system (SIMS); (3) ecological characterization (presently focused on Cape Romain National Wildlife Refuge):, and (4) spatial data analysis service and support (e.g. GIS). These are all important efforts, which are not only important in themselves but also provide valuable models for extension to additional needs and uses. . Significant accomplishments in these areas include the following:

- Development of SIMS, a relational database of water quality and information on molluscan shellfish used in classification of U.S. coastal waters for shellfish harvest.
- Assessment of risk associated with *Vibrio* spp. linked to raw shellfish and methyl mercury concentration in large predators.
- Development of spatial data analysis capabilities for CCEHBR scientists.

- Spatial analysis of southeast fisheries data to identify biologically significant areas in the South Atlantic Bight.
- Provision of spatial data to support research and information on protected species, coral health, and ecotoxicology.
- Provision of database management capabilities, software solutions, computer support, and connectivity for CCEHBR, NMFS, and NIST staff.
- Progress in integration of HML network and communications systems with CCEHBR.

The risk analysis research is an important product of this group and it directly addresses NOAA's mission. The information technology component is absolutely essential to CCEHBR, and will need to be updated as technology advances for CCEHBR's research program to remain competitive.

In summary, this Branch covers essential needs of CCEHBR in the areas of computer and database support, information management, and the use of information to develop approaches for risk analysis. It is necessary that the infrastructure and expertise of the Branch keeps pace with the rapid development of information technologies and increase in environmental information. Care must be taken to make sure that sufficient personnel and resources are maintained in this Branch. It was not clear whether that was indeed the case, and we endorse the importance of these activities and of maintaining appropriate strength in information.

Specific recommendations:

- Ensure that RAIM is sufficiently staffed to support computer and modeling needs of CCEHBR's complete research effort.
- Continue to establish partnerships and collaborations with other institutions and programs focused on environmental data management, to optimize shared resources and capacity for data sharing and integration.
- Maintain computing infrastructure and ensure that it keeps pace with hardware and software developments.

FORENSIC BRANCH

The Forensic Branch is an applied multidisciplinary branch that is staffed with assigned personnel as well as other CCEHBR staff when needed for specific cases. The mission statement of Forensic Branch is:

> *"…to provide technical and scientific support to State and Federal Law Enforcement and regulatory agencies to facilitate the enforcement acts and regulations designed to protect marine resources"*

Capabilities

As an applied science the Forensic Branch provides analytical examination of evidentiary material submitted by State and Federal Law Enforcement agencies in cases involving endangered, protected, or regulated marine species. These cases usually involve violations of Federal regulations such as those codified by the Endangered Species Act, Magnuson Act, and Lacey Act, etc.

Highlights

Outstanding activities of the program include:

1) The Lipid Chemistry program within the Forensic Branch is exemplary. The lipid profiles provide the ability for species identification for evidentiary items that do not contain proteins or DNA markers, such as cosmetics and oils.

2) The Forensic program has developed new protocols for the determination of source of
   a) Marine turtles species
   b) Sciaenidae family
   c) Shark species
   d) Tuna species
   e) Cultured versus wild bass

3) The Forensic program had validated species identification protocols so that they will comply with the rigorous "Daubert Criteria" for the admission of scientific data to the courts.

4) The Forensics program is in the process of developing a Standards Archive that currently holds over 9000 samples

5) Branch staff are very active in organizing workshops and sessions for regional and national meetings and workshops.

6) Strong relationship with leading Forensic Laboratories.

Significance and Impacts

The major significance of the Forensic Branch is that it enables State and Federal Law Enforcement officers to prosecute violators of wildlife laws and thus protect dwindling marine resources. This process fulfills a NOS objective, mainly, the preservation and restoration of US coastal and ocean environments. **There is no other Laboratory in the USA that can assist Federal Law Enforcement officers with marine violations.** The number of legal cases in which the Forensic Branch personnel has participated has exponentially increased since 1995. Additionally, the number of taxa that can be analyzed has also increased impressively.

Branch Strengths

Many of the Forensic Branch strong points have been mentioned above. These include:

- Sole source analytical support for Federal Law Enforcement officers enforcing marine violations.
- An understanding of the Legal system.
- Court accepted science
- Very strong interdisciplinary research.

Branch Weaknesses

- Despite some achievements, the Forensic Branch should increase the number of peer-reviewed publications.
- The Forensic Branch research program lacks a Proteomics component. Since the completion of the human Genomic project the research trend is to investigate the products of gene expression. Proteomics fits this niche exceptionally well and will in the near future be of great assistance to Wildlife Forensic laboratories involved in determining species from evidentiary items of unknown source.
- Lack of an on-staff Veterinary Pathologist.
- Lack of scientists (FTE or contractual). This program currently operates with only 4 scientists and 4 technicians.